Effectiveness of Electrocoagulation Method in Processing Integrated Wastewater Using Aluminum and Stainless Steel Electrodes

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Effectiveness of Electrocoagulation Method in Processing Integrated Wastewater Using Aluminum and Stainless Steel Electrodes

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Abstract. Industrial liquid waste is one type of waste that can pollute the aquatic environment. For this reason, we need a method that can be used to treat wastewater by electrocoagulation method. Electrocoagulation is a method of coagulation by using electric current through electrochemical events. In this research, the treated wastewater by electrocoagulation method was integrated wastewater. This process was carried out where wastewater was placed in electrochemical cells containing electrodes with dimensions of 15 cm x 15 cm. Parameters of varied are electrode types of aluminum and stainless steel sensors with varied voltages of 6, 9 and 12 volts, and varied processing time of 30, 60, 90, 120 and 150 minutes. The optimum conditions for the aluminum and stainless steel sensors are 12 volt voltages and 150 minutes process time. The effectiveness of electrocoagulation of integrated wastewater using aluminum sensor was TDS 88.96%, 50% TSS, COD 87.96%, BOD5 52.98%, PO4 35.37%, Fe 62.5% and Pb 85% with efficiency of current 78, 91%. The effectiveness of using stainless steel ensemble was TDS 80.27%, TSS 57.5%, COD 88.43%, BOD5 74.86%, PO4 42.20%, Fe 46.86% and Pb 88.57% with efficiency current 81.25%. The research has fulfilled the environmental quality standard.

Keywords: wastewater treatment, integrated wastewater, electrode, electrocoagulation

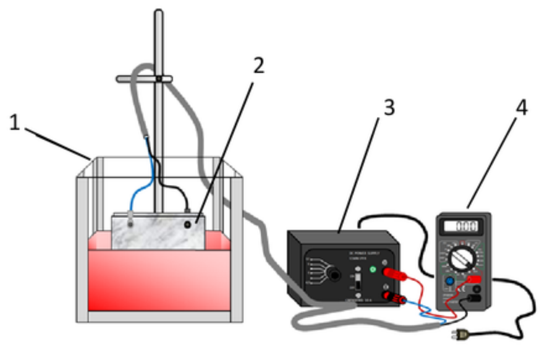
1. Introduction

Waste is the result of waste from a process that cannot be reused. If this waste is too much in the environment, it will have an impact on environmental pollution and have an impact on the health of the surrounding community. Liquid waste is divided into two parts based on the source, namely domestic sourced waste (household waste) and non-domestic waste (factory, industrial and agricultural waste). The main problem faced by water resources includes the quantity of water that has been unable to meet the increasing needs and decreasing water quality for domestic needs. Industrial, domestic and other activities have a negative impact on water resources, including reducing water quality. This condition can cause interference, damage, and danger to living things that depend on water resources. Therefore, careful management and protection of water resources are needed.

One of the chemical wastewater treatment without coagulants is electrocoagulation. Electrocoagulation method is a cheap and effective method of processing industrial waste. Electrocoagulation is an electrochemical method for processing waste where at the anode the active coagulant is released in the form of metal ions (usually aluminum or iron) into the solution, whereas at the cathode an electrolysis reaction occurs in the form of hydrogen gas release. Electrocoagulation techniques have several advantages, namely simple equipment, easy operation, short reaction time. Besides that, during the electrocoagulation process, the salt content does not increase significantly as it does with chemical processing so that pH tends to be constant. The basic principles of electrocoagulation are reduction and oxidation (redox) reactions. In an electrocoagulation cell, an oxidation event occurs at the electrode (+), namely the anode, while the reduction occurs at the electrode (-) namely the cathode. The reaction involved in electrocoagulation in addition to the electrode is treated water, which functions as an electrolyte solution. Electrocoagulation is capable of removing various types of pollutants in water, namely suspended particles, heavy metals, colors on coloring agents, and various other harmful substances.

2. Research and Methods

The electrocoagulation process is a combination of the electrochemical processes, the coagulation-flocculation, and the electrochemical process. This process can be an alternative to liquid waste processing compared to the other processing method [4].



1. Electrochemical cell
2. Electrode
3. Power Supply
4. Multimeter

Figure 1. Batch electrocoagulation system

Electrocoagulation process was carried out on electrolysis container which there are cathode and anode as a conductor of direct current electricity called electrodes. Both cathode and anode were dipped in the wastewater as the electrolyte. The bubble was produced during the electrocoagulation process. After that, the residuals formed in the water rose above the surface of the water. The formed floc had a relatively small size which later it increased in size gradually. After the electrocoagulation occurred in the water, the sedimentation process was carried out to precipitate the particles or the formed floc earlier. After the sedimentation process, the separated wastewater flowed into the membrane. The membrane filtered the wastewater and then the produced effluent was analyzed in the laboratory.

3. Results and Discussion

3.1 Effectiveness of the Electrocoagulation Method in Processing Integrated Wastewater Using Aluminum Electrodes

3.1.1 Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 6 V

The optimum effectiveness was the percentage of COD reduction effectiveness which was equal to 86.34% while the minimum effectiveness was the percentage of PO4 reduction effectiveness which was 32.04%. It can be seen the increase in effectiveness (%) from the duration of 30 minutes until 150 minutes as shown in Figure 2.

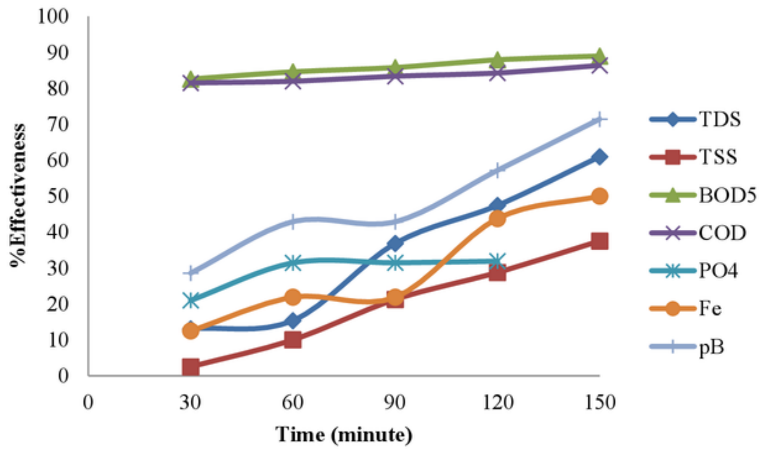


Figure 2. Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 6 V Using Aluminum Electrode

3.1.2 Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 9 V

The optimum effectiveness was the percentage of COD reduction effectiveness which was equal to 84.72% while the minimum effectiveness was the percentage of PO_4 reduction effectiveness which was 0%. There was an increase in the percentage of effectiveness compared to the results at a voltage of 6 V but there were still many variables lower than the percentage of effectiveness at a voltage 6 V results such as COD. This increase indicates that the higher the voltage supplied, the higher the percentage of effectiveness obtained. It can be seen the increase in the effectiveness (%) from the duration of 30 minutes until 150 minutes as shown in Figure 3.

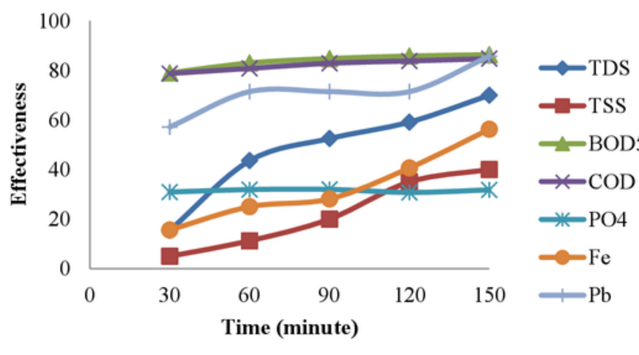


Figure 3. Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 9 V Using Aluminum Electrode

3.1.3 Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 12 V
The optimum effectiveness was the percentage of TDS reduction effectiveness which was equal to 88.97% while the minimum effectiveness was the percentage of reduced effectiveness in PO_4 which was equal to 0.99%. There was an increase in the percentage of effectiveness compared to a voltage of 9 V at a voltage of 12 V. But there were still many variables that were lower than the percentage of effectiveness at a voltage of 9 V such as BOD_5. But the percentage of BOD5 and TSS effectiveness was not stable. It was due to the small difference in the reduction of BOD_5 and TSS concentrations during the processing results. This increase indicates that the higher the voltage supplied, the higher the percentage of effectiveness obtained. It can be seen the increase in the effectiveness (%) of processing COD, Pb, Fe, PO_4, and TDS from the duration of 30 minutes until 150 minutes as shown in Figure 4.

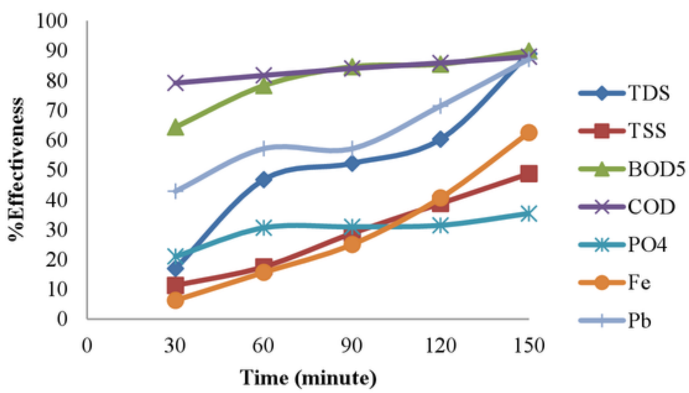


Figure 4. Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 12 Volts Using Aluminum Electrode

3.2 Effectiveness of the Electrocoagulation Method in Processing Integrated Wastewater Using Stainless Steel Electrodes
3.2.1 Effectiveness of Electrocoagulation Method Against Time at a Voltage of 6 V
The optimum effectiveness was the percentage of Pb reduction effectiveness which was equal to 85.71% while the minimum effectiveness was the percentage of TSS reduction effectiveness which was 8.75%. It can be seen the increase in effectiveness (%) from the duration of 30 minutes until 150 minutes as shown in Figure 5.

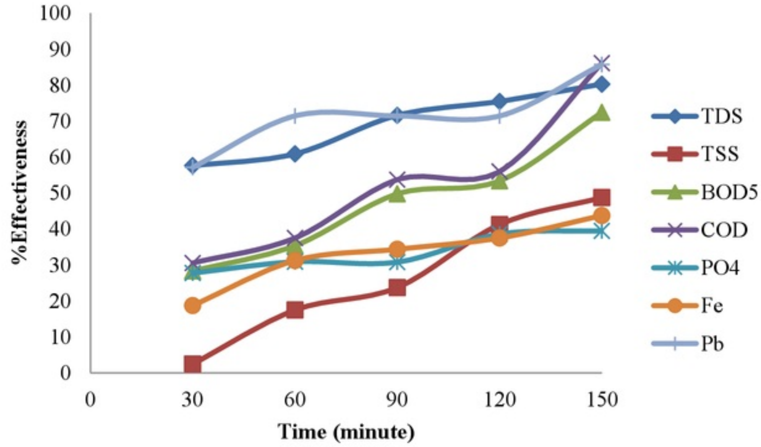


Figure 5. Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 6V Using Stainless Steel Electrode

3.2.2 Effectiveness of Electrocoagulation Method Against Time at a Voltage of 9 V

The optimum effectiveness was the percentage of Pb reduction effectiveness which was equal to 86.11% while the minimum effectiveness was the percentage of PO_4 reduction effectiveness which was 2.5%. It can be seen the increase in effectiveness (%) from the duration of 30 minutes until 150 minutes as shown in Figure 6.

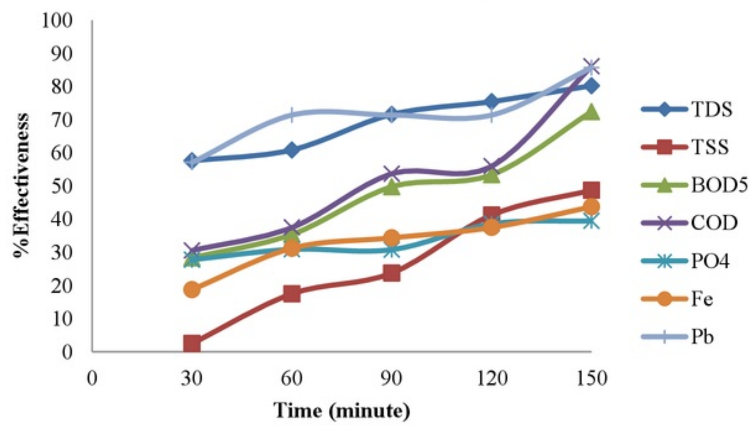


Figure 6. Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 9V Using Stainless Steel Electrode

3.2.3 Effectiveness of Electrocoagulation Method Against Time at a Voltage of 12 V

The optimum effectiveness was the percentage of Pb reduction effectiveness which was equal to 88.43% while the minimum effectiveness was the percentage of PO_4 reduction effectiveness which was 3.75%. There was an increase in the percentage of effectiveness compared to a voltage of 9 Volts and 6 Volts at a voltage of 12 Volts while there were still many variables that were lower than the percentage of effectiveness at a voltage of 9 Volts such as TDS. This increase indicates that the higher the voltage supplied, the higher the percentage of effectiveness obtained. It can be seen the increase in effectiveness (%) from the duration of 30 minutes until 150 minutes as shown in Figure 7.

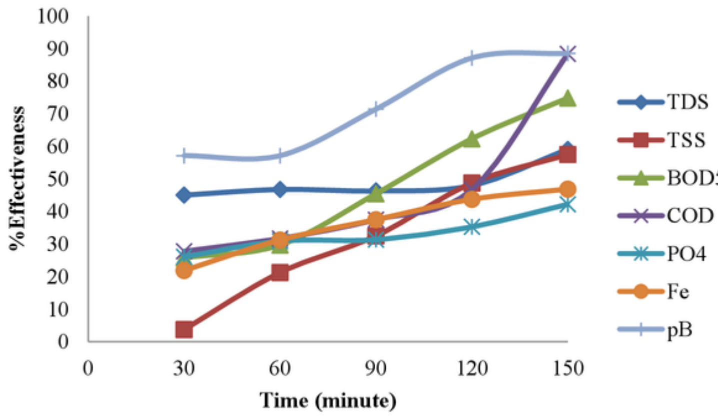


Figure 7. Effectiveness of the Electrocoagulation Method Against Time at a Voltage of 12 Volts Using Stainless Steel Electrode

Conclusions

The effectiveness of electrocoagulation using aluminum electrode for the highest COD value was 87.96%, Pb heavy metal reduction effectiveness of 85%, Fe metal reduction effectiveness of 62.5%, PO_4 reduction effectiveness of 35.37%, BOD_5 reduction effectiveness of 52.98%, TSS reduction effectiveness of 50%, and TDS reduction effectiveness of 88.96%. The optimum effectiveness of electrocoagulation in reducing the pollutants of the integrated wastewater using aluminium electrodes in decreasing TDS concentration was 88.96%. Based on the results of the study, the efficiency of current was 78.91%.

The effectiveness of electrocoagulation using stainless steel electrode for the highest COD value was 88.43%, Pb heavy metal reduction effectiveness of 88.57%, Fe metal reduction effectiveness of 46.875%, PO_4 reduction effectiveness of 42.2%, BOD_5 reduction effectiveness of 74.86%, TSS reduction effectiveness of 57.5%, and TDS reduction effectiveness of 80.27%. The optimum effectiveness of electrocoagulation in reducing the pollutants of the integrated wastewater using stainless steel electrodes in decreasing Pb heavy metal concentration was 88.57%. Based on the results of the study, the efficiency of current was 81.25%.

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